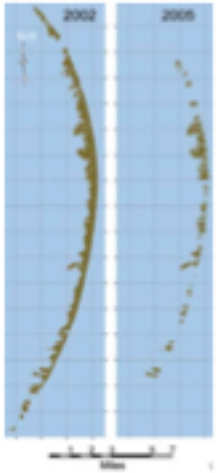
Confronting Climate Change: Implications for the Future of Electric Power

Coal	Cars	The Coast



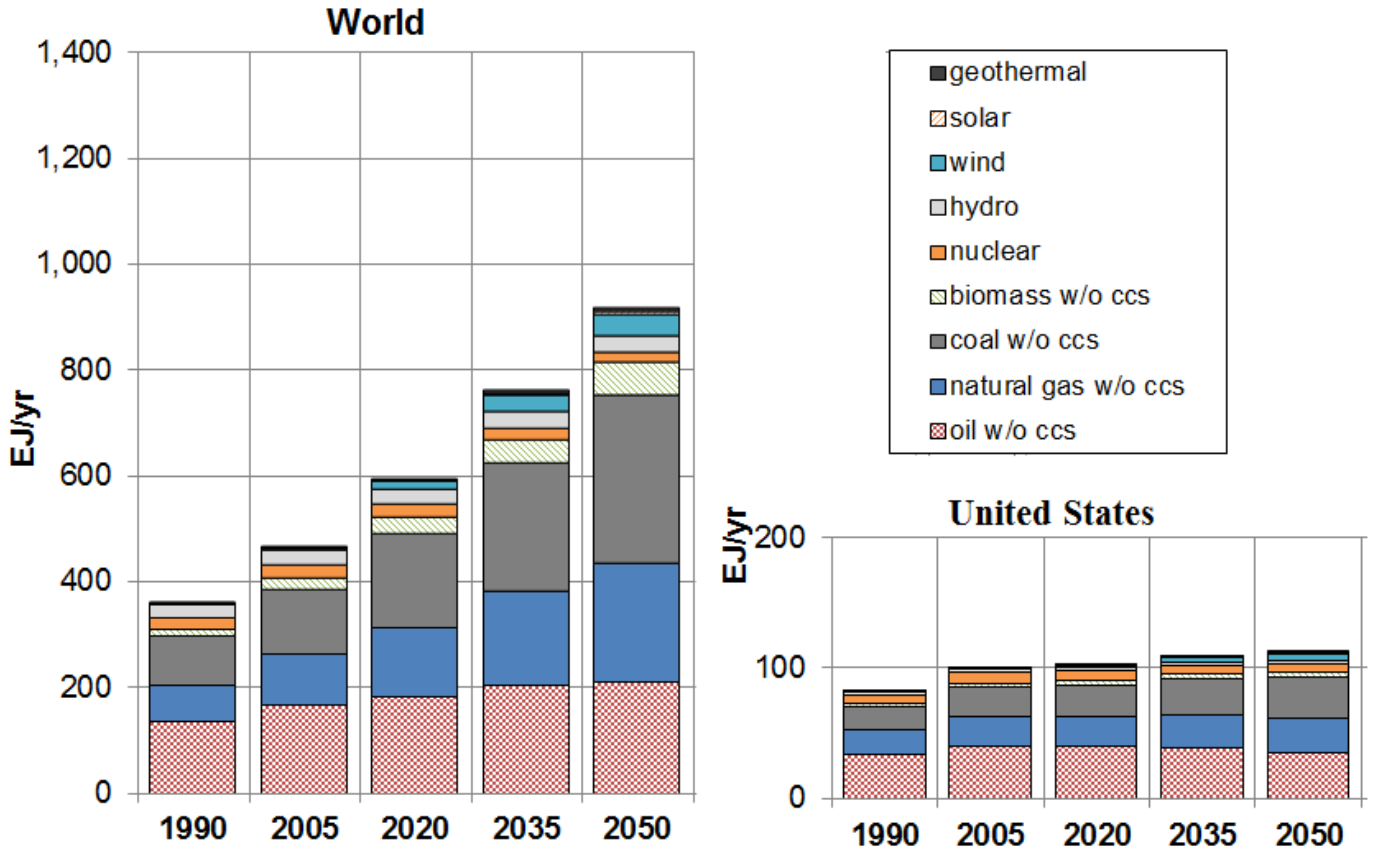
Climate Change Issues

Dr. Marilyn A. Brown
Brook Byers Professor of Energy Policy
Georgia Institute of Technology

Atlanta Science Tavern
October 25, 2014

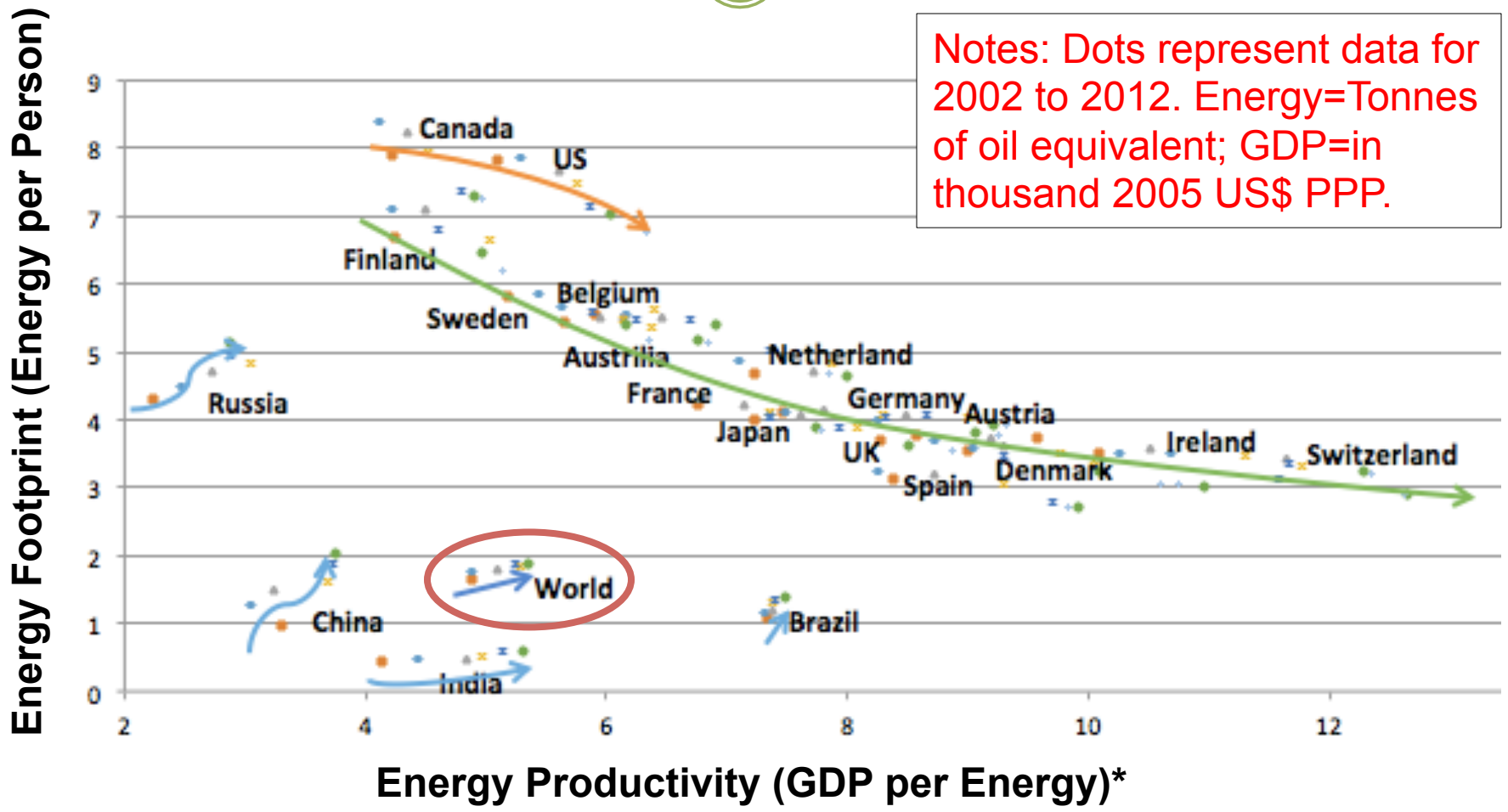
Global Energy Demand Could Rise by One-Third Over the Next 25 Years

Driven by rising living standards in China, India & the Middle East.



Source: International Energy Agency. 2012. *World Energy Outlook.*

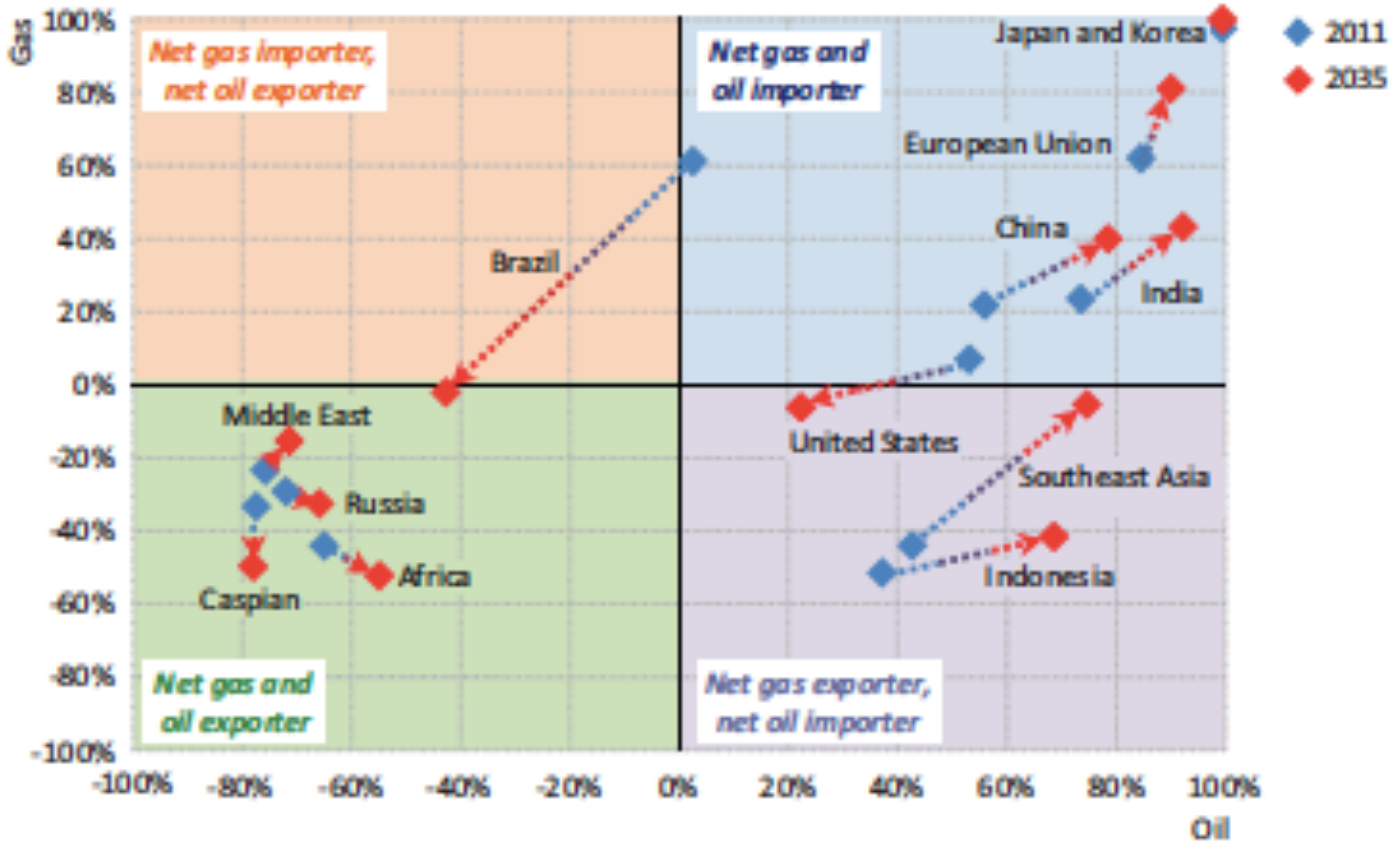
Energy is Being Used more Productively, but Energy Per Capita & Population are Growing



Source: Brown, Marilyn A. 2014. "Enhancing Efficiency and Renewables With Smart Grid Technologies and Policies," *Futures: The Journal of Policy, Planning and Futures Studies.*

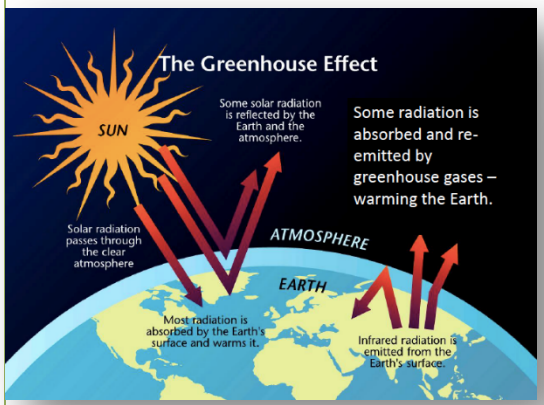
Many Countries are Increasing their Oil & Gas Imports, but not the US

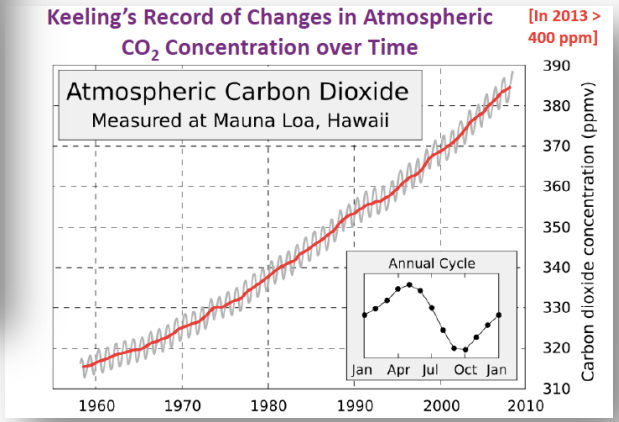
Will the bonanza of affordable natural gas be a bridge or a barrier to a clean energy future?

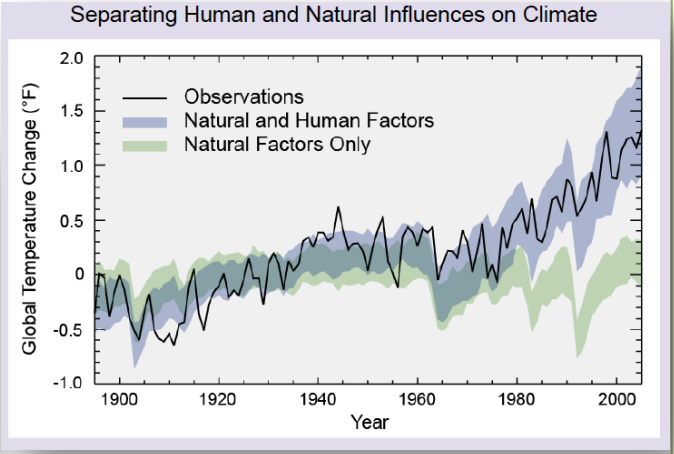


Source: Adapted from International Energy Agency. 2012. *World Energy Outlook.*

The Climate Change Challenge







- "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.

- The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased."

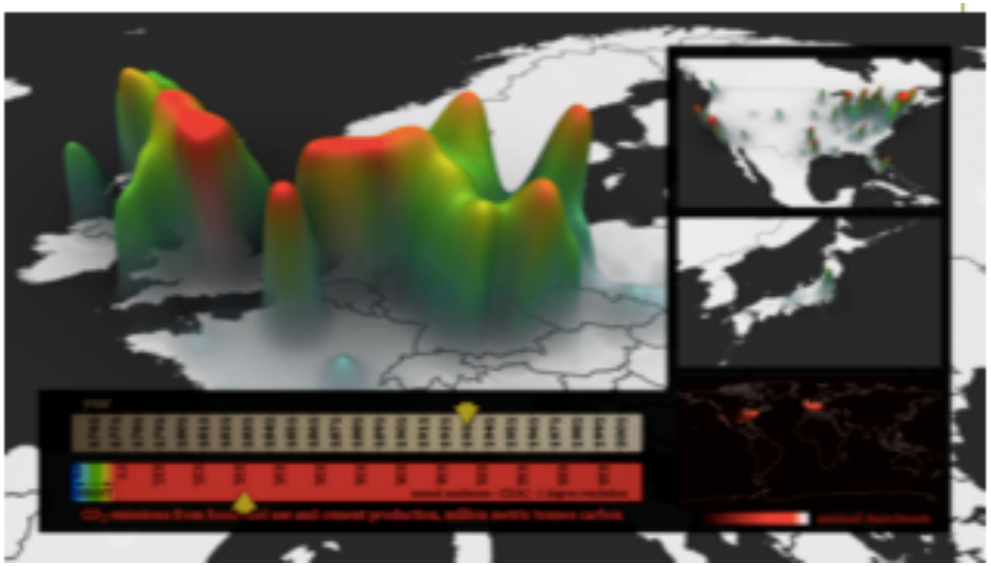
Sources: IPCC. 2013. *Climate Change 2013: The Physical Science Basis* and U.S. Global Change Research Program. 2014. *Climate Change Impacts in the United States.*

Extrapolation of Current Trends Could Raise Surface Temperatures by 6°C by 2100

U.S. average temperature has increased by 1.3°F to 1.9°F since 1895 – mostly since 1970.

The most recent decade was the nation's and the world's hottest on record.

The Southeast has experienced some of the smallest temperature increases over this period.



CO_2 Emission (1751–2006)
Source: Jack Climate Change Science Institute, Oak Ridge National Laboratory, October 15, 2014

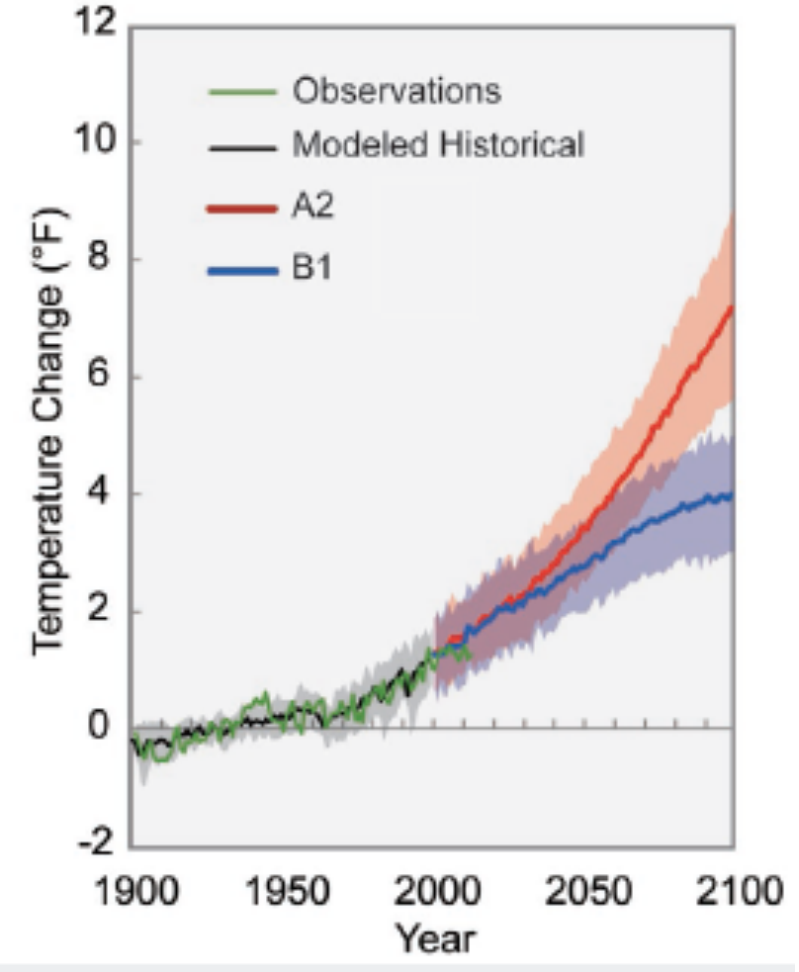
Projected Global Temperature Change

Different levels of GHG emissions from human activities produce different forecasted increases in Earth's temperature.

A2 = Assumes continued GHG emission increases. (=+3-5°F by 2100)

B1 = Significant GHG emission reductions. (=+5-10°F by 2100)

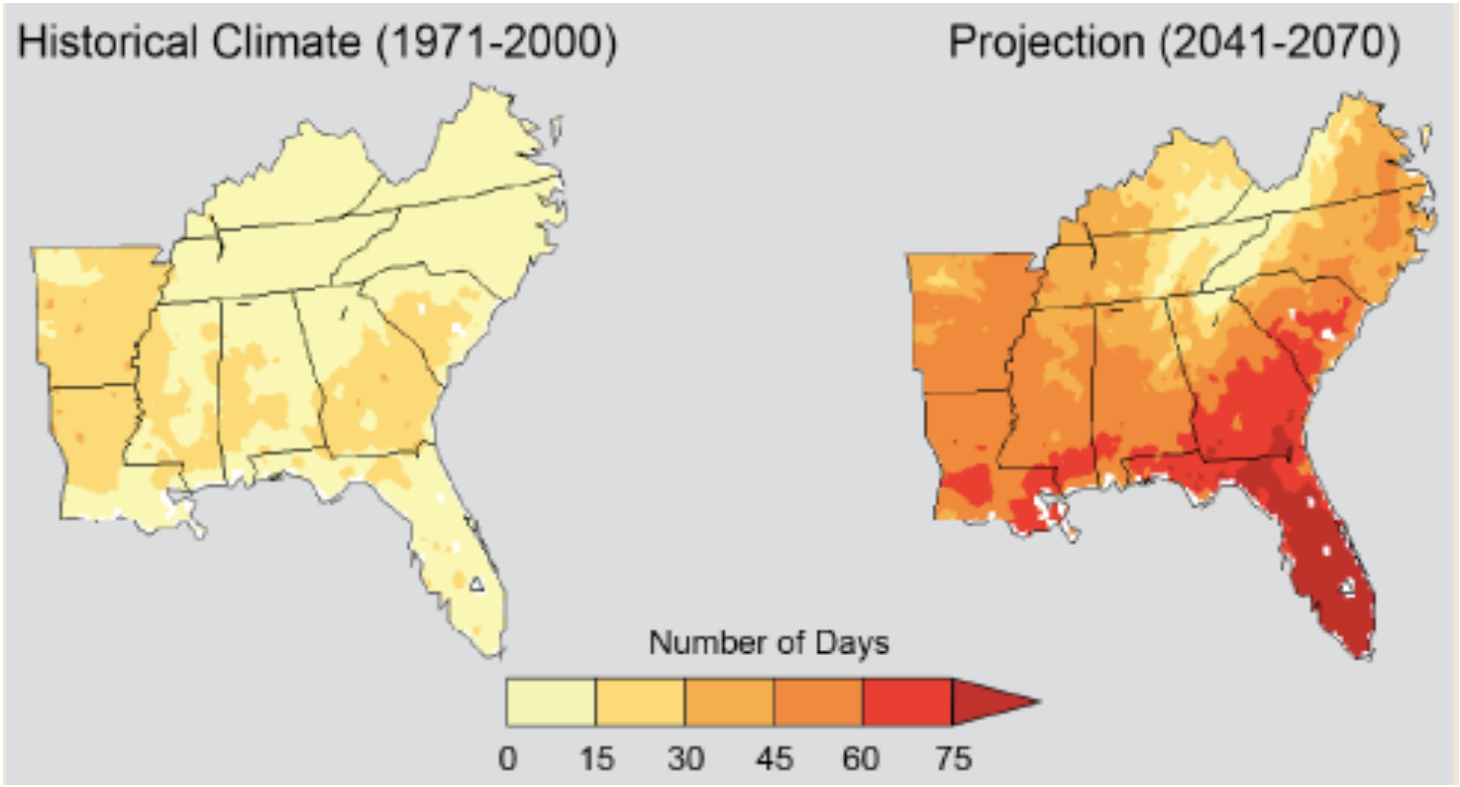
Temperatures are projected to rise 2 - 4°F in most areas of the U.S. over the next few decades.



Source: U.S. Global Change Research Program. 2014. *Climate Change Impacts in the United States.*

In the Southeast, the Number of Days Over 95°F Will Likely Increase

The USGCRP forecasts 45-60 days over 95°F by mid-Century in Atlanta, assuming emissions continue to grow.

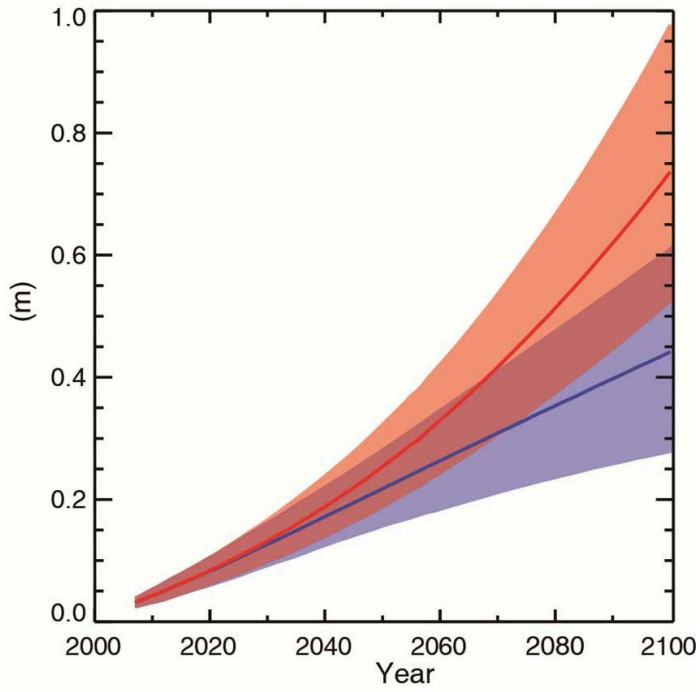


Source: U.S. Global Change Research Program. 2014. *Climate Change Impacts in the United States.*

Forecasts of Sea Level Rise

Sea level could rise by 0.4 meters (with a low-emission scenario) to 0.7 meters (with a high-emission scenario) by the end of the century relative to 2000.

Global Mean Sea Level Rise

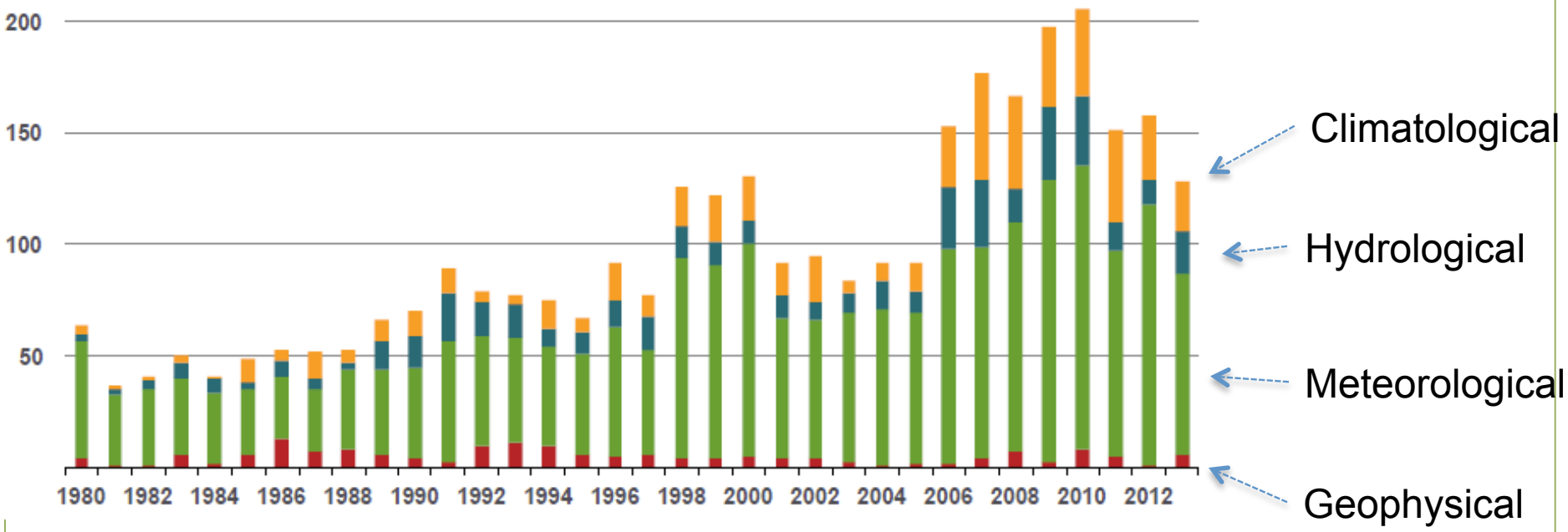


Vulnerability to Sea Level Rise

Source: IPCC. 2013. *Climate Change 2013: The Physical Science Basis*; USGCRP. 2014. *Climate Change Impacts in the United States.*

Natural Catastrophes are Increasing in Frequency, Magnitude & Cost

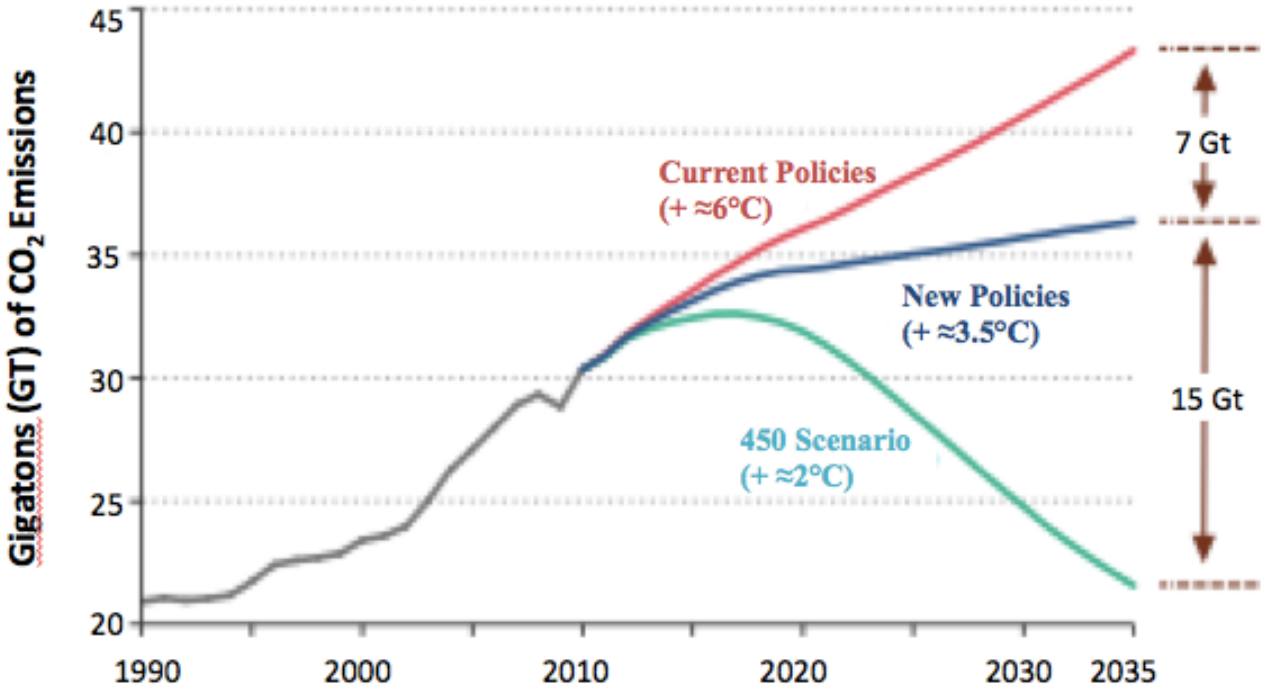
Number of Global Natural Catastrophes: 1980-2013



Source: Munich RE, 2014, *2013 Natural Catastrophe Year in Review.*

The Door is Closing on a 2°C Rise in Global Temperatures by 2100

Four-fifths of the total energy-related CO2 emissions of the 450 ppm Scenario are already "locked-in" by existing capital stock

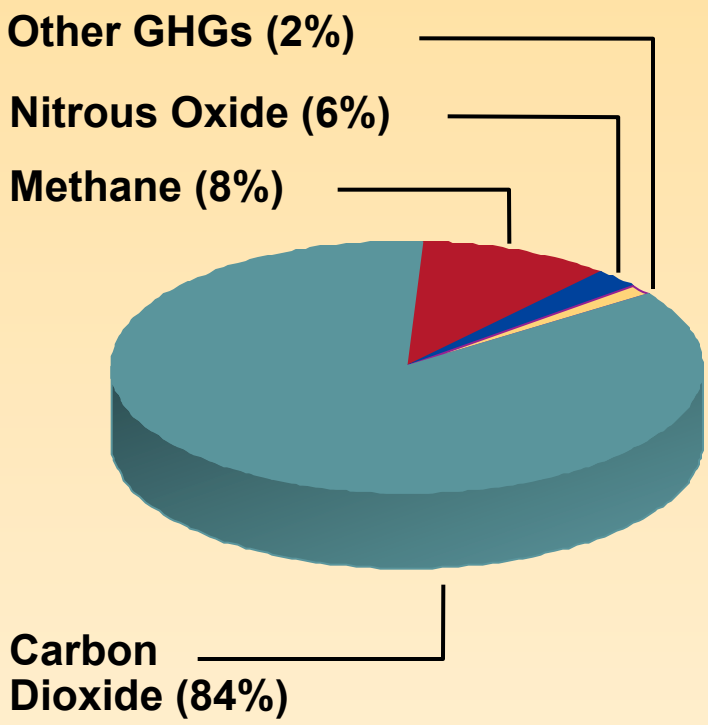


World Energy-Related CO_2 Emissions by Scenario

Source: International Energy Agency. 2011. *World Energy Outlook.*

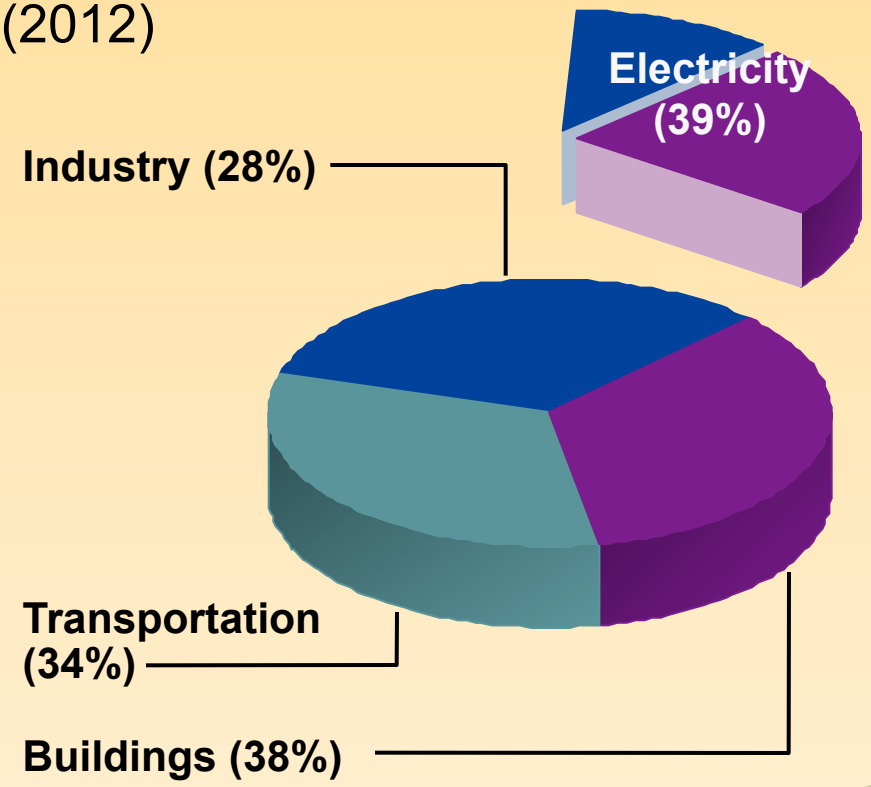
Electricity Generation Accounts for 39% of U.S. CO_2 Emissions

U.S. GHG Emissions
88% are energy related



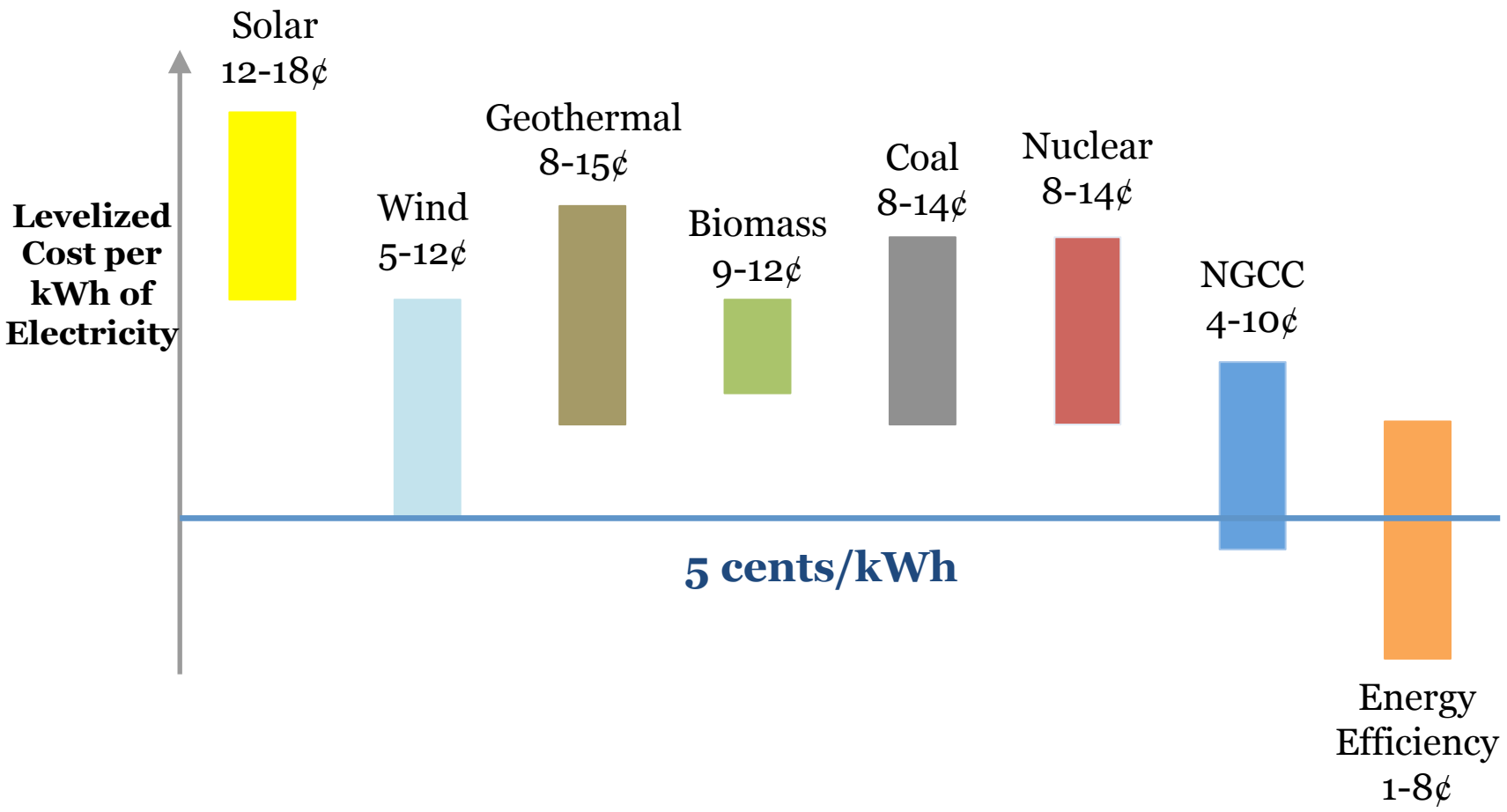
Source: EPA. 2007. *Inventory of U.S. GHG Emissions and Sinks: 1990-1995,* 2007.

U.S. CO_2 Emissions
by Energy Sector
(2012)



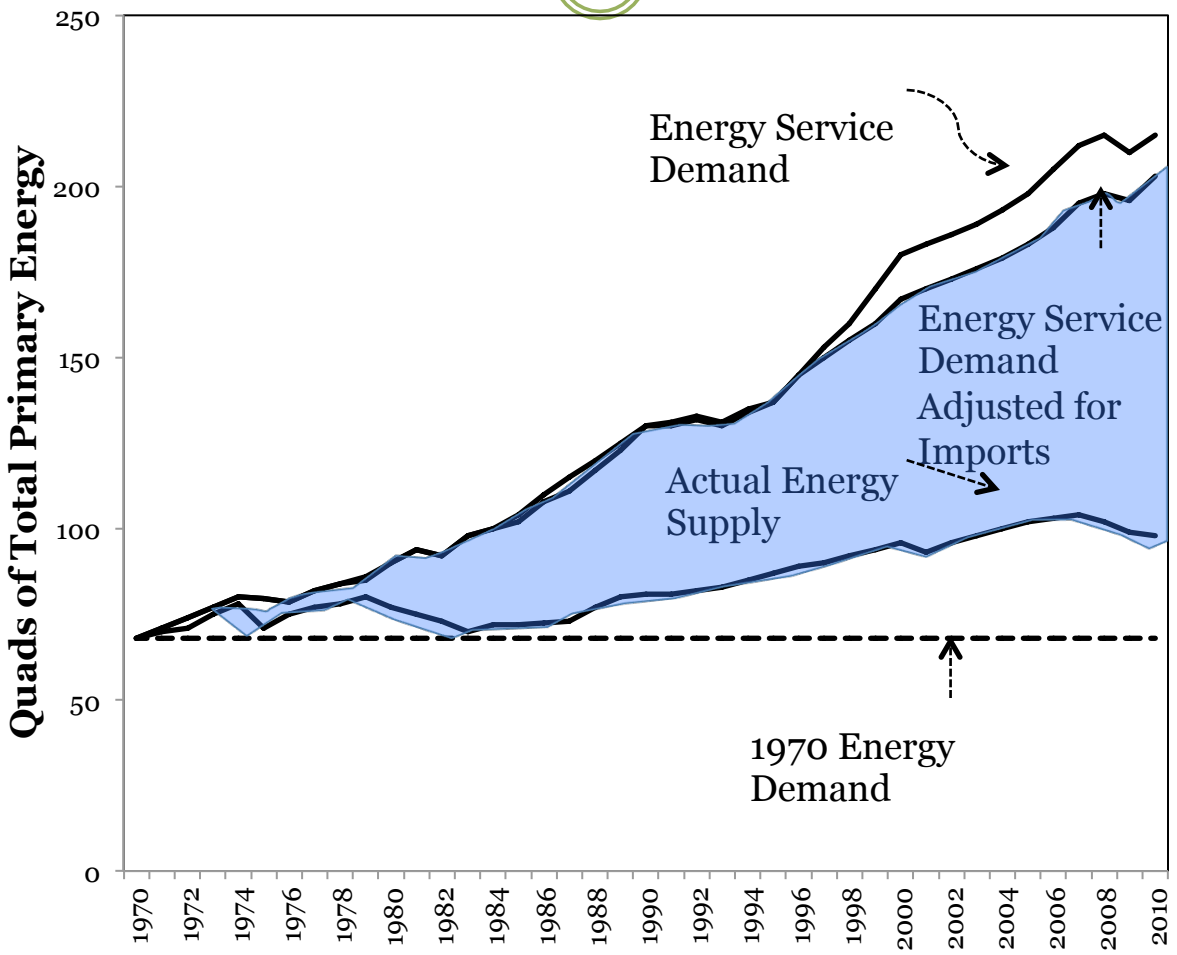
Source: EIA. 2014. *Annual Energy Outlook 2014*, Table A18.

How Can the U.S. Electric Power Sector Mitigate Climate Change and Stay Competitive/Affordable?



Yu Wang (2014) "U.S. Electricity End-Use Efficiency: Policy Innovation and Potential Assessment,' Dissertation, Georgia Tech.
Data: Sustainable Energy in America 2014 Factbook, Bloomberg New Energy Finance.

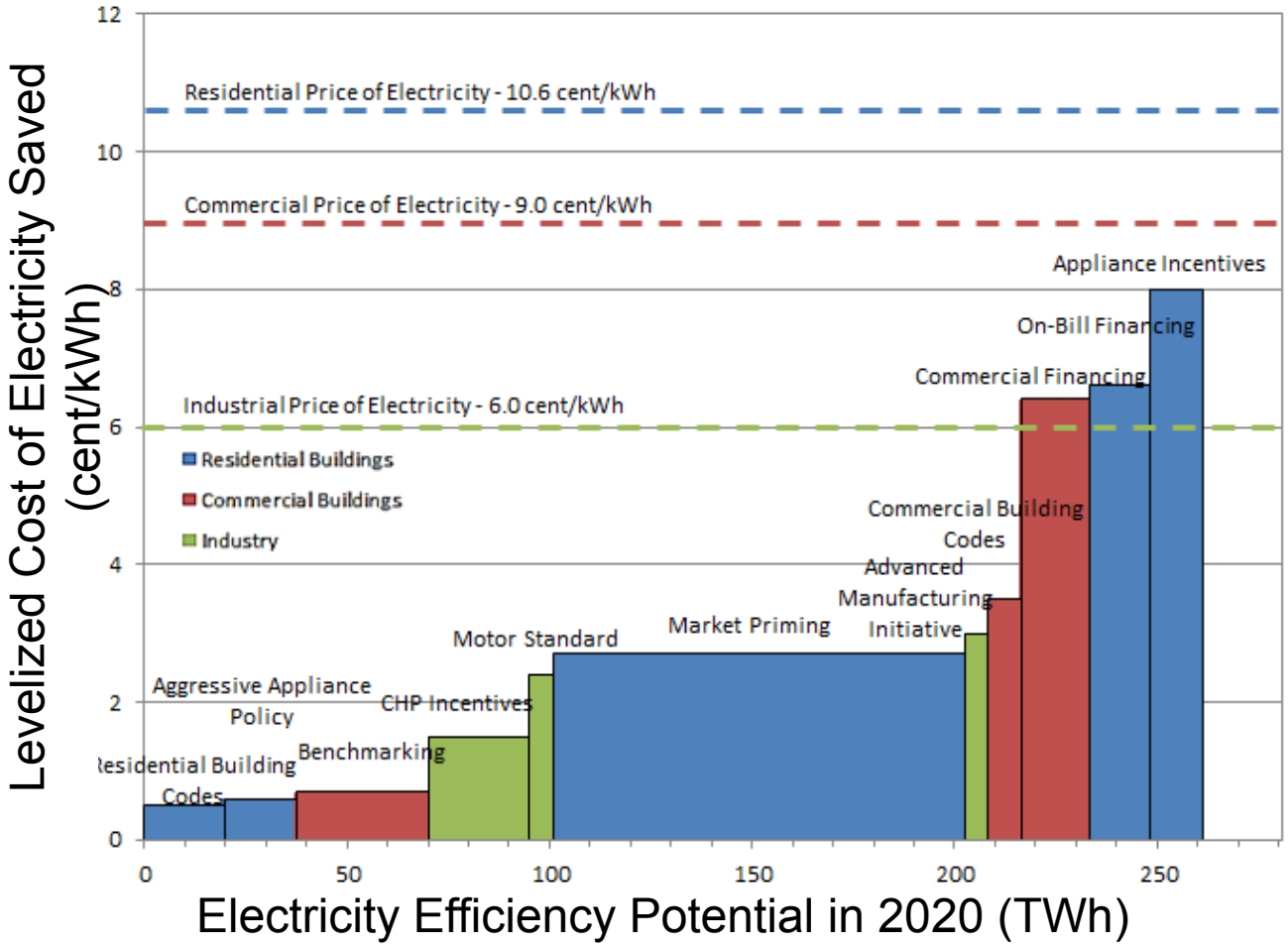
Energy Efficiency (The Blue Wedge): The Most Important Fuel, But Overlooked & Underappreciated



The Energy Efficiency of the US Economy Has Improved

Source: Skip Laitner & Steve Nadel, ACEEE, 2012.

Policies are Needed to Cut Wasteful Electricity Use

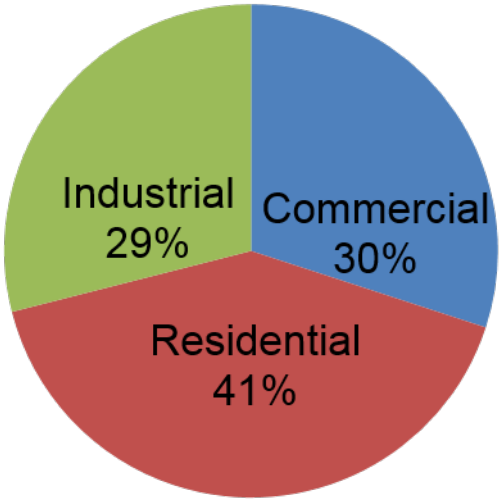


Source: Wang, Yu and Marilyn A. Brown. 2014. "Policy Drivers for Improving Electricity End-Use Efficiency in the U.S.: An Economic-Engineering Analysis". *Energy Efficiency,* 7(3): 517-546.

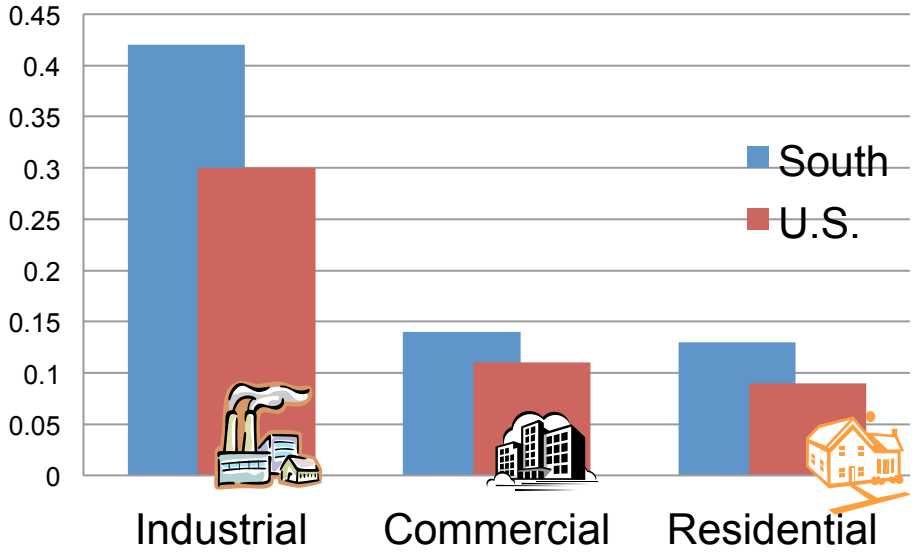
Energy Efficiency Opportunities are Large in Every Sector of the South

The Southeast* accounts for:	But only:
34% of national energy consumption	28% of the U.S. population
33% of national electricity consumption	25% of the U.S. GDP

Delivered Electricity Consumption in the South in 2012 (1.42 Trillion kWh)*

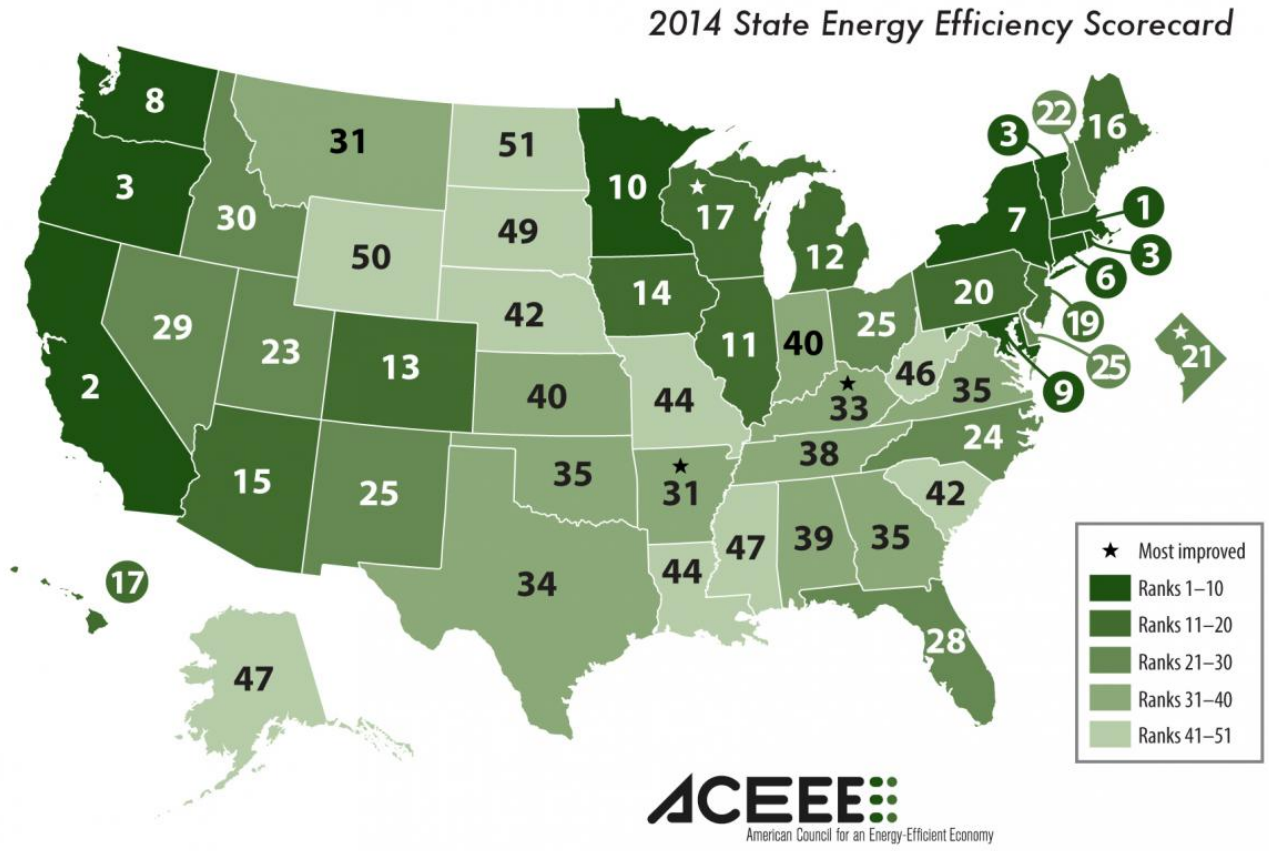


Delivered Electricity Intensity (kWh/$GDP)



*Excludes TX and OK. Sources of data for 2012-2013: GT-NEMS; EIA *Annual Energy Outlook 2013*; BEA.

The South Lags in Energy Efficiency Policies, but is Progressing



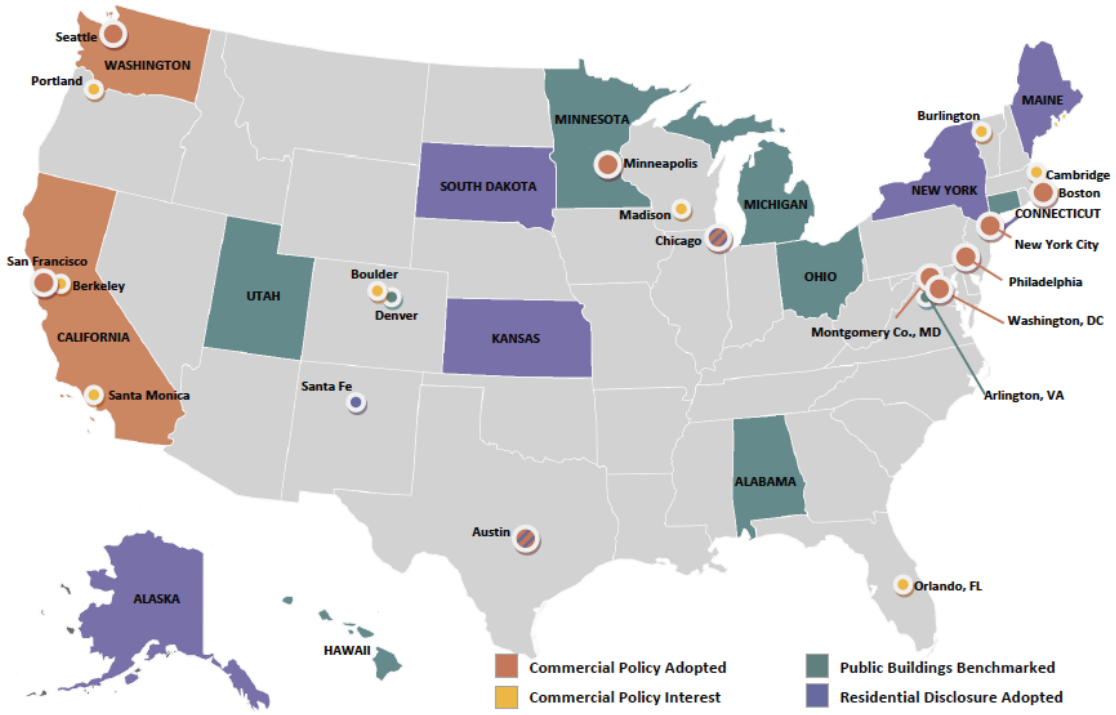
In the Southeast, only North Carolina ranks in the top half.

Source: American Council for an Energy-Efficient Economy. 2014, ACEEE State Energy Efficiency Scorecard Ranking, October

The Power of State and Local Actions

Energy benchmarking:

- makes the real estate market more transparent by informing owners, buyers & renters
- encourages investments in energy efficiency by lowering risk and uncertainty.



Mandated Disclosure of Energy Consumption

Why not Atlanta???

Source: Cox, Matt, Marilyn A. Brown, and Xiaojing Sun. 2013. "Energy Benchmarking of Commercial Buildings: A Low-cost Pathway for Urban Sustainability," *Environmental Research Letters,* Vol. 8, (12 pp).

The Power of Consumer Action

Many meters provide frequent data collection and two-way communication:

- ✓ Powerful when combined with real-time electricity pricing
- ✓ Can interface with in-home, in-office, and smart phone displays of online consumption data

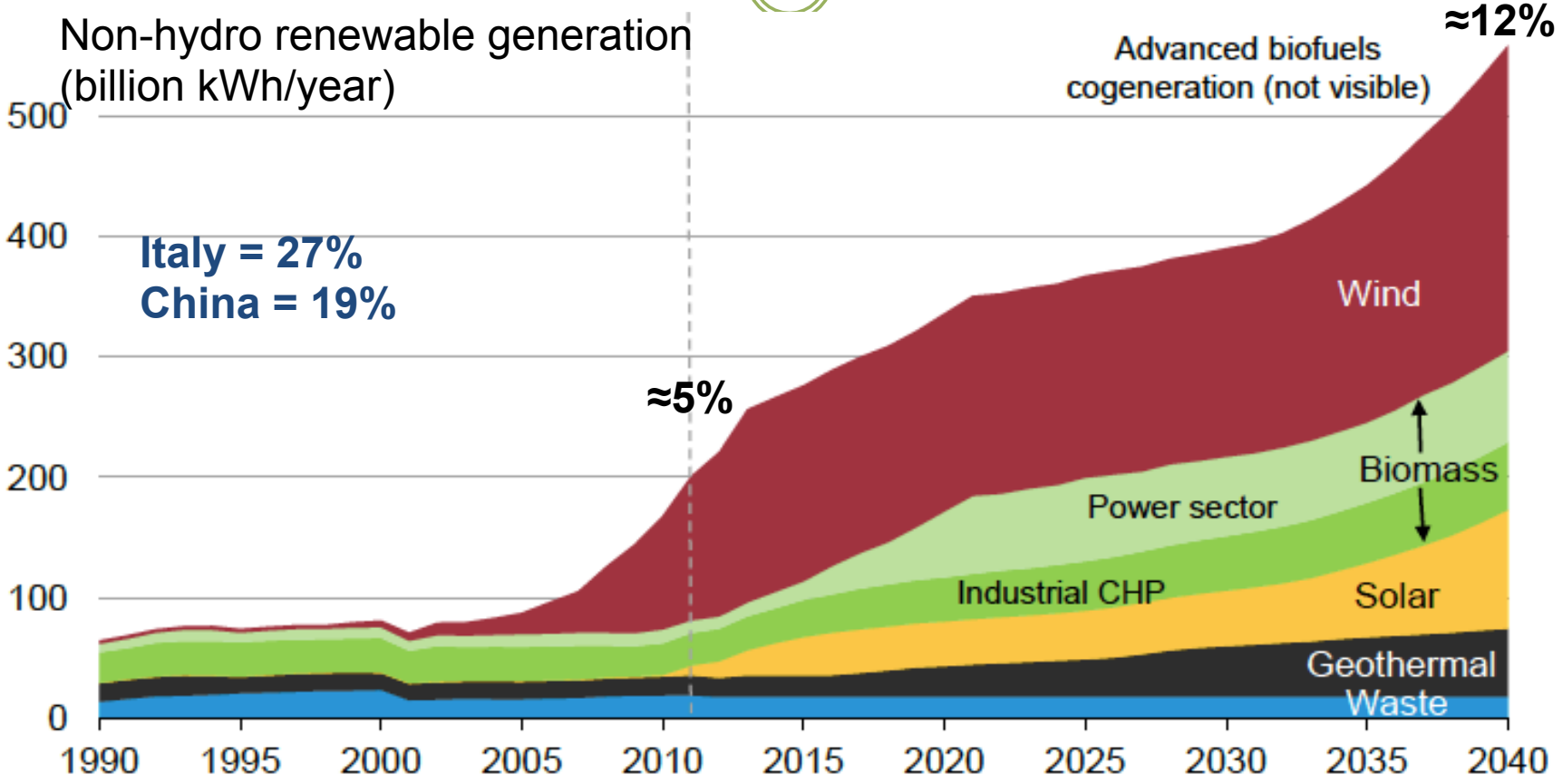
Sensors for temperature, humidity, motion, and light help eliminate wasted energy (and improve comfort).

Google/Nest Learning Thermostat

Improving the Utility Business Model for Energy Efficiency

- Energy-efficiency programs can significantly reduce the electricity bills of participants.
- Non-participant bills may also decline.
- But, utility earnings can also be reduced, unless business models are altered to restore them. Options include:
  - ✓ Rate-basing program costs,
  - ✓ Recovery of lost contributions to fixed costs, and
  - ✓ Provision of utility incentives
- This range of options and the growing scope and scale of energy-efficiency programs makes the choice of business model increasingly important.

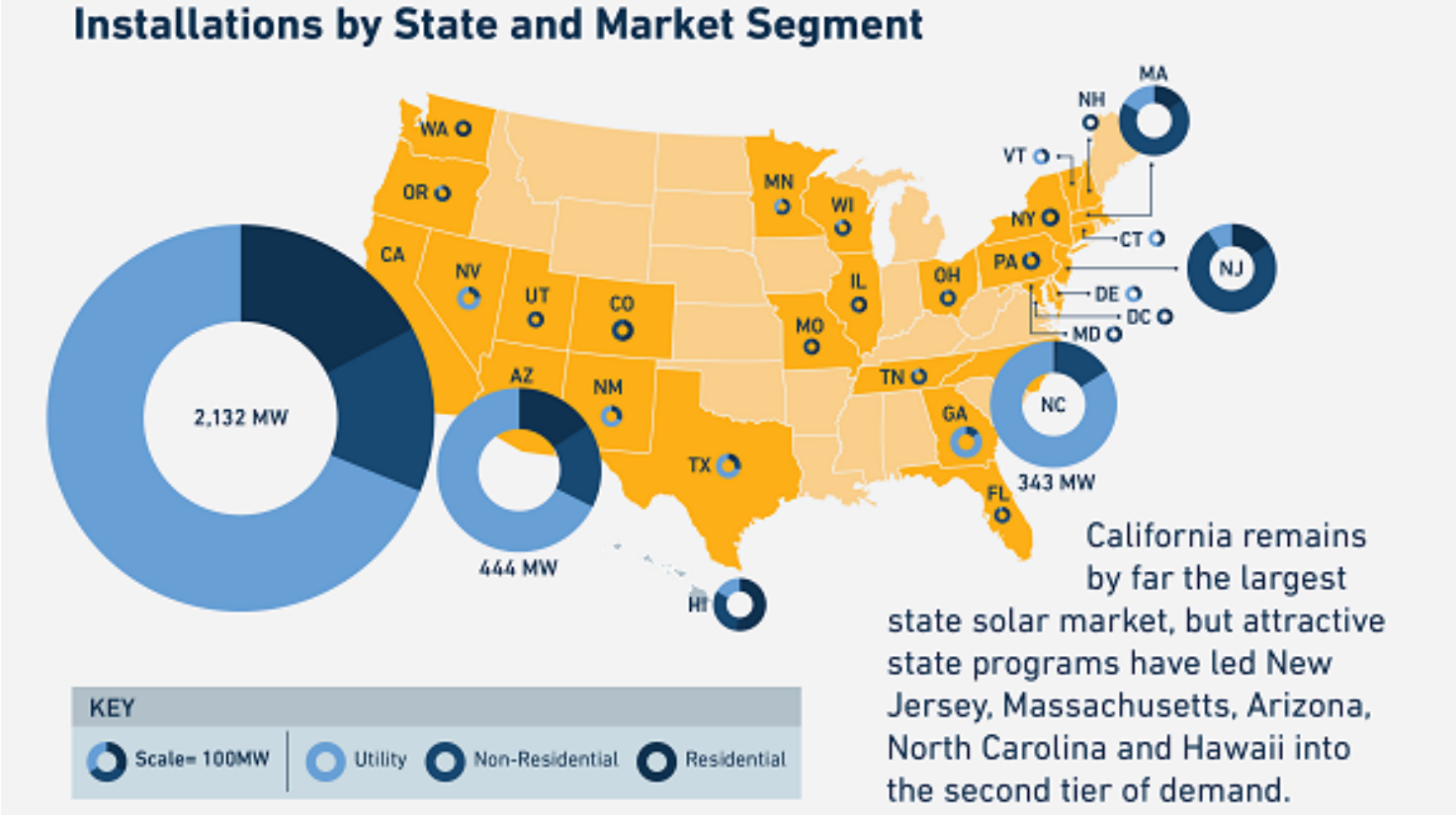
What about Renewables?



The Energy Information Administration forecasts that non-hydro renewable generation will triple by 2040, with wind, biomass, & solar dominating.

Source: EIA, *Annual Energy Outlook,* 2013

NC and GA Lead the South in Solar Installations



Source: Solar Energy Industry Association, http://www.greentechmedia.com/articles/read/Infographic-State-of-US-Solar-2013

Georgia Power Has Two Solar Programs

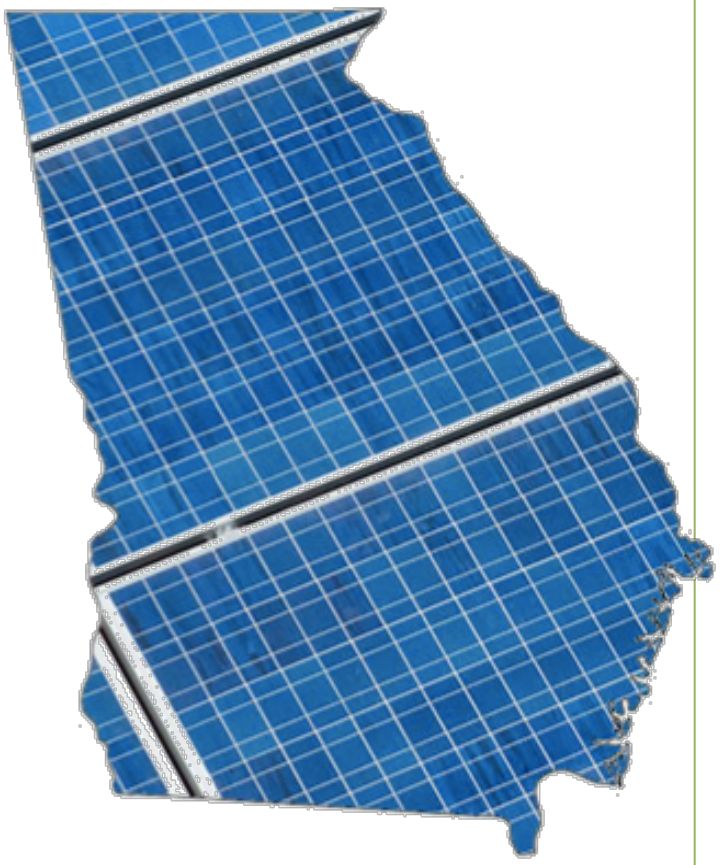
Advanced Solar Initiative (ASI) = 13¢/kWh: 820 rising to 1600 participants in 2015

- ✓ will contract for 210 MW of solar capacity by the end of 2014.

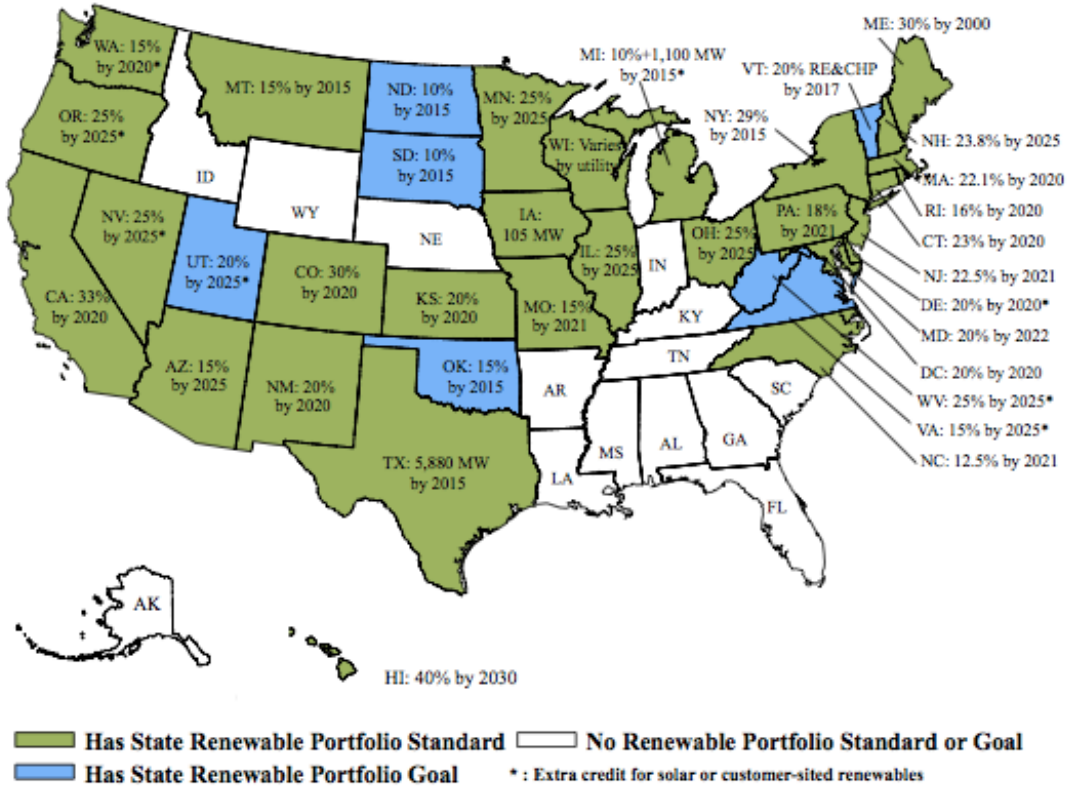
Solar Purchase-1 Tariff (SP-1) = 17¢/kWh: participation tied to revenues from Earth Cents Program (a green power purchase program).

- ✓ RFP for the acquisition of 60 MW of solar generation capacity each in 2013 & 2014.
- ✓ Small generators (≤ 100 kW) are eligible to sell their electricity back to GPC.

Larger customers (≤ 80MW) may sell their electricity as a Qualifying Facility.

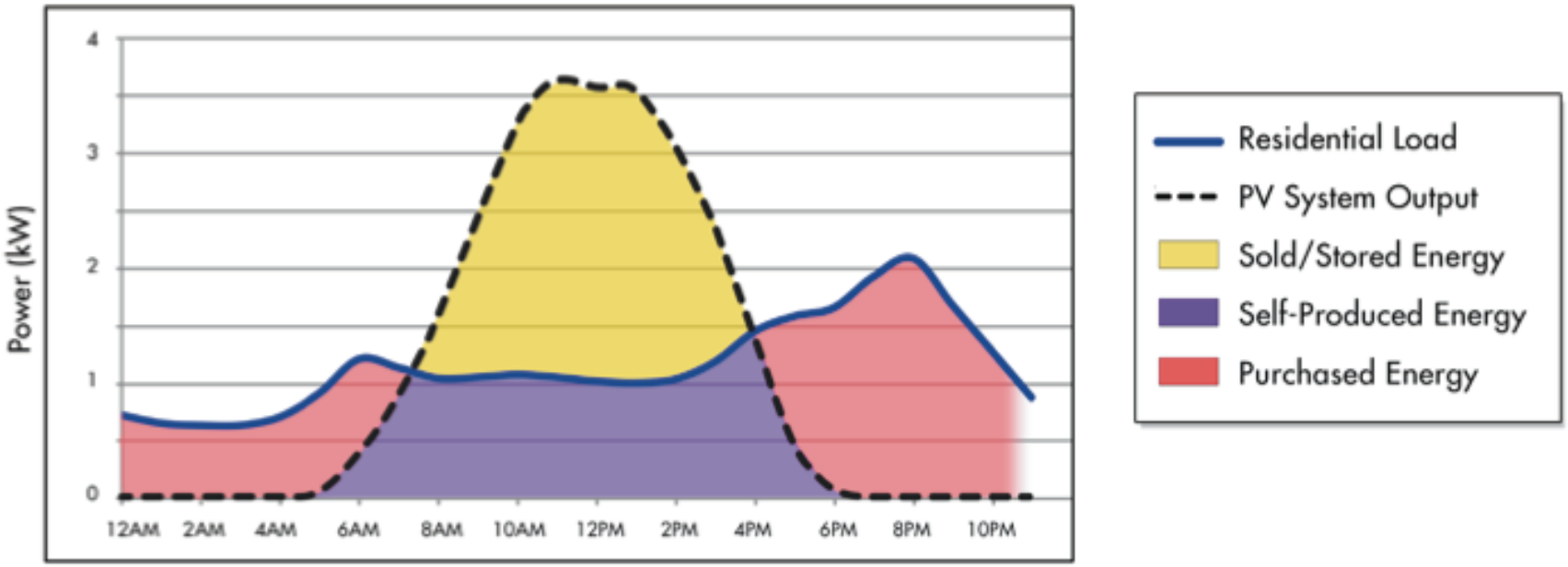


Few Southern States have Renewable Portfolio Standards (RPS)



The Southeast is the biggest block of States without an RPS.

A Challenge for the Grid: Demand & Solar Photovoltaic System Output are not Coincident



How will utilities cover the fixed costs of operating the grid and providing back-up generation for intermittent renewables?

Source: Electric Power Research Institute. 2014. *The Integrated Grid*

The Administration's Clean Power Plan

- On June 2, 2014, EPA proposed state-specific limits on CO_2 emissions from existing fossil fuel plants
  - expressed in pounds of carbon dioxide per net megawatt hour
  - would collectively achieve U.S. carbon emissions reductions of 30 percent below 2005 levels by 2030
- EPA is expected to publish the final rule in mid-2015.
- States will have until June 30, 2016 to submit their action plans but can request extensions until June 2017 for individual plans, or until June 2018 for multistate plans.

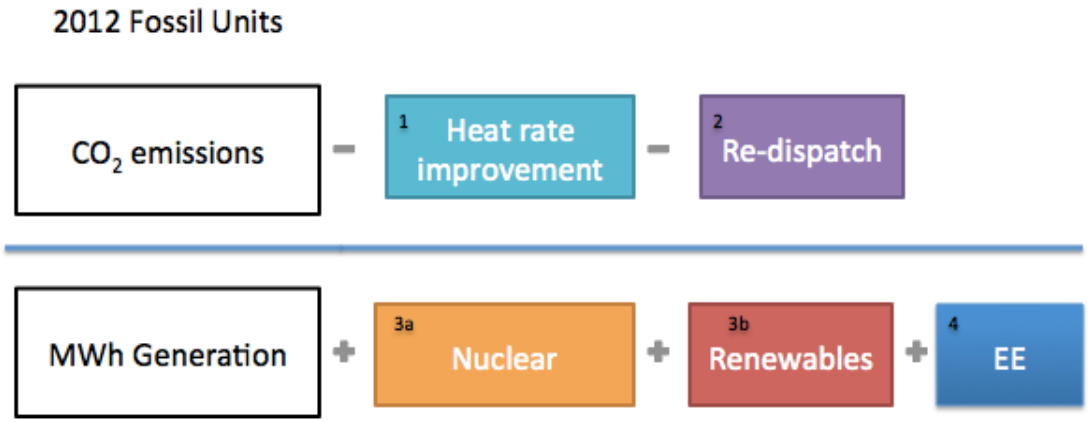
If Enacted, the New Regs Will Boost the Transition to a Low-Carbon Power System

The Goals for Selected Southern States:

	2012 Rate (lb/MWh)	2030 Goal (lb/MWh)
AL	1,518	1,059
GA	1,598	834
KY	2,166	1,763
MS	1,185	692
NC	1,772	992
TN	2,015	1,163
VA	1,438	810

See more analysis of the Clean Power Plan, by Georgia Tech: http://cepl.gatech.edu/drupal/node/75

How the Goals are Calculated



Sources: 2012 Rate from EIA data, Final Goals from EPA Preamble

Grounds for Optimism

- Clean energy technologies are improving
  - renewable markets are growing
  - the “double dividend” of energy efficiency is expanding.
- Most of the 2050 physical infrastructure is not yet built – with growth comes opportunity
  - to “lock in” clean energy technologies
  - to “climate proof” systems whenever infrastructure investments are being made.

For More Information

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CLIMATE AND ENERGY POLICY LABORATORY
SCHOOL OF PUBLIC POLICY

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